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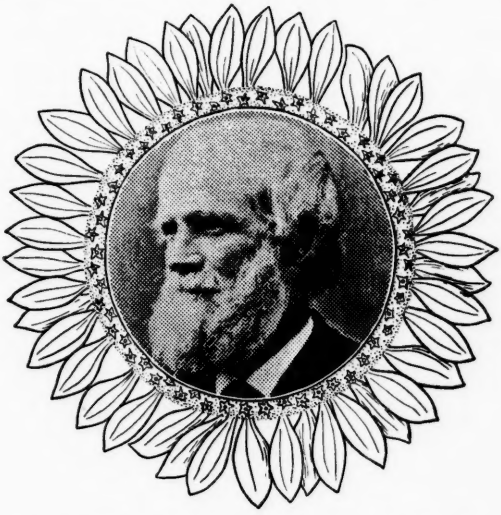

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# THE SMARTWEED BORER (Pyrausta ainsliei Heinrich, Lepidoptera) IN KANSAS*

BY

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A study of the smartweed borer **Pyrausta ainsliei** Hein. was begun in the fall of 1929 at Manhattan, Kansas. This insect is of considerable interest as it is the nearest American relative of the European corn borer, **Pyrausta nubilalis** Hubn. It is scarcely distinguishable from the European corn borer in appearance and it is similar also in life history and habits. There is some possibility that parasites now attacking the smartweed borer may change their habits sufficiently to enable them to utilize the European corn borer as a host.

The purposes of this study were first to accumulate information which might have a bearing on the seriousness of the European corn borer as a pest in Kansas, and, second, to determine whether or not the smartweed borer is likely to develop into a pest on cultivated crops, particularly corn.

A review of the literature shows that considerable work has been done in the past on the smartweed borer. However, the greater part has been incidental to investigations on the European corn borer. No investigations

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have been conducted on this insect in Kansas, the point farthest west where the biology of the insect has been studied being Ames, Iowa.

Until 1919 the species **Pyrausta ainsliei** had not been distinguished from **Pyrausta penitalis** Grote. **Pyrausta penitalis** was first described by A. R. Grote as **Botis penitalis** in 1876. He states that it is common and feeds on the receptacle of the American Iotus (**Nelumbo lutea**). In 1890 it was redescribed by John B. Smith as **Botis nelumbialis.** In 1880 Coquillett published some notes on a species he believed to be **Botis penitalis** which was later shown to be different.

Scouts looking for the European corn borer found larvae of **Pyrausta ainsliei** in corn stalks in 1919 at Milford, Massachusetts. They were reported as the corn borer and specimens were sent to Mr. Carl Heinrich who identified them as a new species of **Pyrausta** which had been confused with **Pyrausta penitalis.** Mr. Heinrich named the new species **ainsliei.**

### Methods and Materials

The studies of the development of the larvae and the general work of organization were carried on in the laboratory at Manhattan. Tests were made at the field insectary to secure data on pupation, emergence, host preference, host specificity and, also to supply data concerning the parasites of the smartweed borer. Work in the field consisted in the location of areas of infested smartweed and dissection of infested smartweed to determine the percentage of pupation and parasitism. This also supplied borers for experimental work.

### Distribution

The smartweed borer is widely distributed over the eastern part of the United States. Its range extends north as far as Quebec and south along the Atlantic coast to Mississippi and Louisiana. Its western limit has been reported as Kansas. It seems probable that it occurs virtually everywhere in the United States east of the Rocky Mountains where its favorite food plants grow.

The insect was noted in abundance by Dr. E. G. Kelly in 1926 in the vicinity of Manhattan, Kansas. Dickinson County is as far west as the insect has been taken, but as it was fairly abundant there it is probably distributed farther west. Surveys have been made in

Dickinson, Geary, Riley and Pottawatomie Counties.

### Host Plants

In the following discussion the host plants of the smartweed borer are referred to by numbers.

(1) **Polygonum pennsylvanicum** L. (Smartweed).
(2) **Polygonum lapathifolium** L. (Smartweed).
(3) **Polygonum hydropiperoides** Michx. (Smartweed).
(4) **Polygonum persicaria** L. (Ladies thumb).
(5) **Polygonum avicular** L. (Dooryard knotweed).
(6) **Persecaria scandens** L. (Wild false buckwheat).
(7) **Rumex crispus** L. (Curled dock).
(8) **Rumex** sp. (Dock).
(9) **Fagopyrum fagopyrum** Karst. (Buckwheat)
(10) **Castalia** sp. (Water lily).
(11) **Typha latifolia** L. (Cat tail).
(12) **Eupatorium** sp. (Joe-pye weed).
(13) **Ambrosia artemisiifolia** L. (Ragweed).
(14) **Ambrosia trifida** L. (Giant ragweed).
(15) **Amaranthus retroflexus** L. (Pigweed).
(16) **Amaranthus hybridus** L. (Pigweed).
(17) **Abutilon Theophrasti** Medic. (Velvet leaf).
(18) **Zea mays** L. (Corn).
(19) **Xanthium** sp. (Cocklebur).
(20) **Chenopodium album** L. (Lambsquarter).
(21) **Helianthus annuus** L. (Sunflower).
(22) **Helianthus** sp. (Sunflower).
(23) **Apocynum androsaemifolium** L. (Spreading dog bane).

The following plants have been reported as food plants of the smartweed borer, (1), (2), (3), (4), (11), (12), (19), (20), (23) and Ainslie, and Cartwright (1921) reared specimens on leaves of curled dock (7) and buckwheat (9). To test some of these plants and a few others, one male and five female moths were confined in a 3 ft.x6ft.x4 ft. screen cage containing the following plants, (1), (5), (6), (8), (9), (13), (14), (15), (16), (17), (18), (19), (20), (21), and (22). One egg mass was found on (15) and eight on (1). The one on (15) did not develop and only three on (1) are known to have hatched. There was no damage to any

of the plants other than (1), smartweed. Some moths were confined in a cage with a buckwheat plant, (9) June 6, and an egg mass was laid on the underside of one of the lower leaves June 8. A spider was found feeding on the eggs June 14. None of the eggs hatched. Experiments in trying to force larvae of the smartweed borer to feed on a series of plants were carried out at the field insectary. In these, the larvae were confined in vials with the leaves of the following plants, (1), (2), (5), (8), (9), (13), (15), (16), (19), (20) and (21). The only ones on which feeding occurred other than the smartweeds (1) and (2) were buckwheat (9) and dock (8) and the borers on these died before reaching maturity.

As there was some difficulty in getting the moths to oviposit, some of the eggs collected on smartweed were used to infest other plants. The piece of leaf on which the egg mass was attached was fastened to a leaf of the plant to be tested by means of a paper clip. In one of these tests a water lily, (10), growing in the greenhouse was treated in this manner and examined daily. The eggs hatched and young larvae were observed feeding on the smartweed leaf for only one day. After that there was no indication of infestation although the daily examinations were continued for six days after hatching. Similar tests were made at the alfalfa plot with the following plants, (1), (7), (8), (9), (14), (17), (18), (20), (21), and (22). None of these plants became permanently infested and none showed injury from borers although freshly hatched larvae were noted crawling on the leaves of the corn plant. The check in this group also failed to become infested, although of four plants of smartweeds, (1), growing among the alfalfa a short distance from this group and treated in the same manner, two became infested.

September 19, 1929, two third instar larvae were confined in a glass jelly jar with a young corn plant. On September 28 both were dead and there were no signs of feeding on the corn.

The only plants on which the larvae were found feeding under natural conditions were the smartweeds, (1), (2), and (4). Other species of **Polygonum** occur around Manhattan but have not been studied thoroughly. There is a possibility that they may also be utilized at times as food plants.

Tests with other plants conducted at the field house would indicate the possibility of rearing specimens on some of the docks and on buckwheat. There is no evidence that the insect is able to utilize corn as a food plant. While buckwheat was utilized when nothing else was obtainable it was not touched when **Polygonum pennsylvanicum** was available.

For some reason, many of the larvae leave the smartweeds and seek protection in any plant that will give them dry quarters during the winter. Ainslie and Cartwright (1921) stated that the list of these shelter plants will eventually include virtually all of the pithy stemmed plants which the larvae are able to penetrate. It is not likely that this habit has economic significance. The burrows are not extensive and are made at a time of year when the crops which might be affected are practically mature. The possible injury would be increasing the breaking over of corn stalks. There was very little migration into cornstalks here in the fall of 1929. Only one of one hundred stalks in favorable situations for infestation by migrating borers, was found infested. Possibly this is due to the comparatively light infestation at Manhattan.

### The Egg.

The eggs of the smartweed borer are flat and scale-like and are laid in masses containing 6 to 21 eggs, with each egg overlapping the one in front. The egg has been described by Ainslie and Cartwright (1921). The eggs collected at Manhattan were not distinctly greenish in color, those laid on waxed paper being translucent white when first laid. The eggs laid by moths in confinement were somewhat smaller than those described by Cartwright. Ten eggs laid on waxed paper in masses averaged 0.998 mm. long and 0.870 mm. broad. Five others laid singly under the same conditions averaged 0.900 mm. long and 0.825 mm. broad. Some of the eggs collected in the field June 3 and 4 hatched June 8.

Observations here of the development of the egg agree with Ainslie and Cartwright (1921) for the most part. The period of incubation was found to vary from 5 to 14 days. An egg mass, in a large screen cage, laid on smartweed June 18, hatched 5 days later, June 23, while another mass laid on May 29, on waxed paper and kept in a bucket with moist earth hatched June 12, a period of 14 days.

The eggs are translucent and almost colorless when first laid. Soon a white opaque ring appears near the margin leaving a more transparent spot in the center. In the case of eggs hatching in five days the head capsules are plainly visible one day before hatching. It is possible to watch the movements of the larvae through the chorion. They are easily disturbed and react to a touch by opening and closing their mandibles. The heads of the larvae within the eggs usually face away from the laying moth, toward the upper overlapping side of the egg. It is practically impossible to see the outline of the larval body inside the egg, however by opening an egg with a needle the body was found coiled about the head capsule which is in the approximate center of the egg.

### The Larva

In Kansas, appearance of the larva of the smartweed borer generally agrees with the description by Ellis (1925), however it was noticed that in some cases there was a considerable variation in size and color. Many of the mature larvae were smaller than Ellis' measurements. There was also a wide color difference ranging from a dark lead color or olive grey to a light yellowish grey, sometimes even pinkish. The spots on the dorsum of the darker specimens are heavily shaded while those on the lighter ones are usually smaller and lightly shaded.

The larva of this insect resembles the larva of **Pyrausta nubilalis** so closely that it is often impossible to distinguish between the two without the use of a microscrope. The distinguishing characteristics are explained by Heinrich, (1919). Fig. A, page 6, illustrates the arrangement of setae on the head of **P. nubilalis.** Fig. G, is the corresponding view of **P. ainsliei.**

Observations at Manhattan on the hatching and behavior of the larvae agree in general with those of Ainslie and Cartwright (1921) and Poos (1927). The eggs were usually laid on a leaf near the top of the plant, the larvae hatched in about 5 to 14 days and entered the stem in a group about 2 or 3 inches from the tip, apparently without first feeding on the leaves.

The injuries resulting from the feeding of smartweed borers on the host plants are of two types; that caused by the feeding of groups of very young larvae

near the tips of the branches and that from the individual burrowings of the older larvae in the larger stems. The young larvae enter the smartweed stem about two or three inches from the tip in a group and feed together in their burrow until about the second instar when the tip becomes badly wilted and the borers move out and scatter making their individual burrows in the internodes lower on the stems. These larvae enter the stems by cutting a circular hole just above a node and feed on the succulent tissue inside the tough outer layer. The burrows are kept clean and the frass disposed of by putting it out the entrance where it sometimes hangs by webbing in a loose cluster. When the food is used up in the internode the borer migrates to another for a fresh food supply and continues until the stem may contain several burrows.

When the larva enters the prepupal stage it becomes inactive and spins anteriorly a number of partitions of silk part way across its burrow. When the burrow is opened, these partitions appear as a series of three or four sheets of silk stretched about halfway across the burrow at a small angle to the burrow and in different planes. At the rear of the larva there is a thicker silk webbing without definite plan, which separates the larva from the frass with which the burrow is plugged. When the insect is well within the prepupal stage the body appears to shrink away from the larval skin and becomes shorter taking the shape of the pupa. Toward the end of this stage the insect is unable to use its legs. The prepupa however has the ability to bend the body though it appears to have difficulty in doing so.

Instar studies at Manhattan show the instars slightly shorter and the head capsules slightly smaller than those recorded by Poos (1927). These data are shown in the following table. The study does not include all the instars. According to Ainslie and Cartwright (1921) there are six instars with possibly five only, in the summer generation.

**Table I** **Measurements of First Four Instars**

| Instar | Number of specimens measured | Number of days in instar | Measurement of Head Capsule | Measurement of body length Beginning of instar | Measurement of body length End of instar |
|---|---|---|---|---|---|
| 1 | 5 | Average 2.4 | .33 mm. | 1.00 | 2.46 mm. |
| | | Minimum 2. | .33 | 1.00 | 2.10 |
| | | Maximum 3. | .33 | 1.00 | 2.85 |
| 2 | 5 | Average 3.4 | .48 | 2.88 | 4.22 |
| | | Minimum 2. | .45 | 2.25 | 3.60 |
| | | Maximum 6. | .525 | 3.75 | 4.80 |
| 3 | 4 | Average 3.5 | .720 | 4.53 | 6.81 |
| | | Minimum 3. | .660 | 3.70 | 6.00 |
| | | Maximum 4. | .750 | 6.00 | 7.20 |
| 4 | 2 | Average 6.5 | .976 | 7.0 | 8.5 |
| | | Minimum 6. | .900 | 6.0 | 8.0 |
| | | Maximum 7. | 1.05 | 7.0 | 9.0 |

### The Pupa

The pupa of the smartweed borer is described by Heinrich (1919). His illustration Fig. A, Plate 9, shows the front which bears a characteristic tubercle distinguishing it from the closely related species.

The beginning of spring pupation was not observed in Kansas and only five counts of the percentage of pupation were made during the pupation period. To arrive at the probable dates of spring pupation it was necessary therefore to calculate them by subtracting 27 days, the average length of the pupal period of five reared individuals, from the dates of emergence in the cages. This placed the beginning of pupation about April 26, and the end about May 19. The following table shows the actual percentage by count in comparison with that calculated by the above method. The work was not continued through the period of summer pupation. The first pupating larva of the summer generation was noted on July 1, this individual hatched June 10.

**Table II. Percentage of Pupation**

| Number of Specimens examined | Date | Per cent pupation by actual count | Probable per cent pupation in field by calculation |
|---|---|---|---|
| 63 | May 3 | 27.0 | 39.7 |
| 45 | May 5 | 53.4 | 51.5 |
| 16 | May 9 | 93.8 | 81.0 |
| 47 | May 11 | 74.5 | 88.5 |
| 12 | May 25 | 75.0 | 100. |

### The Adult

The original description of the adult of **Pyrausta ainsliei** is given by Heinrich (1919). The adults of the smartweed borer usually are found in this section of Kansas wherever their favorite food plants occur. Infestation was greatest in low shaded locations. Observations on the habits of the adults and their type of flight agree closely with those of Ainslie and Cartwright (1921).

Emergence in the cages began May 24, and ended June 15, the peak of emergence being about June 1. The daily emergence is shown in the following table.

There appears to be a difference in the rate the sexes emerge, the females apparently emerge at a relatively uniform rate while the males emerge toward the early part of the period.

**Table III** **Table of Emergence**

*Sex of some individuals not recorded.

| Date | Emergence of P. ainsliei | | | Emergence of Parasites | |
|---|---|---|---|---|---|
| | Male | Female | Total | Pyraustomyia penitalis | Macrocentrus n. sp. |
| May 24 | ? | ? | *1 | | |
| May 25 | ? | ? | *3 | | |
| May 26 | 1 | 0 | 1 | | |
| May 27 | 0 | 0 | 0 | | |
| May 28 | 5 | 4 | 9 | 2 | |
| May 29 | 4 | 1 | 5 | | |
| May 30 | 5 | 0 | 5 | | |
| May 31 | 3 | 0 | 3 | | |
| June 1 | 5 | 3 | 8 | | 3 |
| June 2 | ?+7 | ?+2 | *12 | 1 | 1 |
| June 3 | 2 | 1 | 3 | 3 | |
| June 4 | ?+1 | ?+2 | *4 | | 1 |
| June 5 | 1 | 0 | 1 | 4 | |
| June 6 | 0 | 2 | 2 | | |
| June 7 | 0 | 3 | 3 | | |
| June 8 | 1 | 1 | 2 | 2 | 1 |
| June 9 | 0 | 0 | 0 | | |
| June 10 | 0 | 0 | 0 | | |
| June 11 | 0 | 1 | 1 | 1 | 4 |
| June 12 | 0 | 2 | 2 | 4 | |
| June 13 | 0 | 1 | 1 | 1 | |
| June 14 | 0 | 1 | 1 | 2 | 4 |
| June 15 | 0 | 1 | 1 | 1 | |
| June 16 | 0 | 0 | 0 | 2 | |

The life of the adults was short in confinement and they seldom deposited eggs. Many of the eggs laid

under these conditions failed to hatch. The moths were in some instances given dilute honey but showed no preference for the food, taking water alone as readily.

Oviposition habits of **P. ainsliei** were observed by the examination of smartweed plants in this locality, with the following results:

| | |
|---|---|
| Plants examined | 210 |
| Plants infested | 33 |
| Average number of egg masses on the infested plants | 1.727 |
| Average number of eggs in an egg mass | 11.1+ |
| Maximum number of eggs in an egg mass | 21.0 |
| Minimum number of eggs in an egg mass | 6.0 |

**Table IV. .... Location of 53 Egg Masses on the Leaves of 21 Plants**

| Location | Below Center | Near Center | Above Center | Total | Percentage |
|---|---|---|---|---|---|
| Along midrib | 15 | 17 | 9 | 41 | 77.4 |
| Just off midrib | 3 | 4 | 0 | 7 | 13.2 |
| On disc of leaf | 3 | 0 | 1 | 4 | 7.5 |
| Near margin of leaf | 1 | 0 | 0 | 1 | 1.9 |
| Total | 22 | 21 | 10 | 53 | 100. |
| Percentage | 41.5 | 39.6 | 18.9 | 100. | |

### Parasites

The following parasites have been reared in Kansas from **P. ainsliei:**

**Pyraustomyia penitalis** Coq.
**Microbracon caulicola** Gahan.
**Macrocentrus** n. sp.
**Trichogramma minuta** Riley

Others which emerged from caged smartweed but are not known for certain to be parasites of **P. ainsliei** are:

**Bassus agilis** Cress.
**Calliephialtes notandus** Cress.
**Chelonus** sp.
**Diplazon laetatorius** (Fab.)
**Eupelmus rosae** Ashm.
**Eupelmus cyaniceps** Ashm.
**Microgaster zonaria** Say.

**Apanteles** sp.

**Pyraustomyia penitalis** Coq. appears to be the most important of the parasites at Manhattan. Oviposition habits of this tachinid are described by Allen (1922). Oviposition was not observed in Kansas.

Four adults emerged from 25 individually caged larvae of **P. ainsliei.** Three of these appeared as puparia May 9, two emerged on June 5, and the third on June 7. The fourth evidently was abnormal as it was somewhat smaller in size, and appeared as a puparium May 30, emerging June 21. The pupation period for the first three were as follows: 28 days in the case of the first two; 30 days for the third and 23 days in the fourth case.

In the emergence cages the flies emerged from May 28 to June 16, the peak being about one week later than its host. From the material from which 68 **P. ainsliei** emerged, 23 of these **Tachinids** appeared. The emergence data is shown in Table III.

**Microbracon caulicola** Gahan, the first parasite to appear in the spring at Manhattan is small reddish-yellow Braconid. It passed the winter in a silken cocoon outside the dead host body in the smartweed stems. Most of the emergence occurred before April 23 in vials, though a few delayed until June 28. As many as 12 of these Braconids have emerged from one host larva; the average was 3.88.

One generation of this parasite was reared in the laboratory. A female was placed in a vial with second and third instar borers June 12. Larvae of the parasite appeared June 26, spun silken cocoons in the vial and three male adults emerged July 5. The female was still alive when the larvae appeared. Attempts at mating were noted several times in the cages but whether or not mating actually occurred is not known.

Of 67 larvae of **P. ainsliei** cut from smartweeds May 2 and 3, ten or 14.93% had been killed by these Braconids. These parasites were also taken in the field May 2 by sweeping smartweeds. At this time eggs of **P. ainsliei** were found on smartweeds. Some of these eggs hatched June 3. A test to determine the effect of different kinds of treatment on the length of life of the adult **M. caulicola** was as follows: six females all of which emerged from the same larva were divided into

three pairs and each pair placed in a vial. The first pair was given no food and only sufficient water to keep the vial moist. The second pair was placed in a vial with a full grown larva of **P. ainsliei** and given water the same as the first. The third pair was given dilute honey in addition to the water. They lived as follows:

Vial Number 1, lived 9 and 11 days respectively.

Vial Number 2, lived 8 and 9 days respectively.

Vial Number 3, lived 26 and 27 days respectively.

There was one other parasite reared from the 25 individual cages, **Macrocentrus** n. sp., a rather large Braconid, reddish-yellow in color and quite slender. It appeared as a pupa May 8, and emerged June 5. In the emergence cages 14 emerged from the material from which 68 **P. ainsliei** emerged. This is shown in Table III. The emergence period was from June 1 to June 14, about one week later than the peak of emergence of its host.

Four specimens of **Trichogramma minuta** Riley were reared from an egg mass of **P. ainsliei** collected at Ashland Bottoms on June 4. Adults emerged from the eggs June 10 and parasitized the eggs of the forage looper **Caenurgia erechtea** Gn. and of the garden webworm **Loxostege similalis** Guen. Adults appeared from these June 21. The first four adults emerged 6 days after collection, the second generation emerged 10 days after the introduction of the eggs and 11 days after the emergence of the first generation.

**Bassus agilis** Cress was reported as a parasite of **P. ainsliei** in Dettmar W. Jones' list. It has also been found parasitizing the larvae of another Lepidopteron of the family Gelechiidae, **Aristotelia absconditella** Walker, which is a borer in smartweed in Kansas. It has not yet been found parasitizing the larvae of **P. ainsliei** in the work carried out at Manhattan.

## Summary

Life history studies on the smartweed borer at Manhattan, Kansas show that eggs appeared in the field by June 2, and that the duration of the egg stage varied from 5 to 14 days. Eggs collected in the field hatched June 8. On July 1, the first larva from the field collections pupated. Pupation in the spring occurred from approximately May 3 to May 25, and the pupal stage was about 27 days. The emergence period extended

from May 24 to June 15. The number of food plants appears to be fewer than that reported from eastern United States. Four species of parasites were reared from the smartweed borer, one of which was Macrocentrus n. sp. Five others appeared from smartweeds infested by the borer.

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# STUDIES ON THE GENUS CICADULA (HOMOPTERA, CICADELLIDAE)

*BY*

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The writer became interested in the genus Cicadula during the summer of 1929, when many specimens were caught in the light trap. A number of these specimens were sent to different Cicadellid authorities and with some species the determinations did not agree. A great deal of variation seemed to occur in the species determined as **Cicadula sexnotata.** In face of the economic importance of at least one species of the genus it was felt that proper identification should be assured before control measures were considered. It was thought that the internal genitalia of the males might give some clue to the proper identification. With this thought in mind, the writer has attempted to settle the identity of several species of Cicadula found in North America.

In general, the members of this genus are small and quite elongate. The vertex is longer on the middle than next the eye but not strongly produced. The pronotum is short, the anterior margin more or less convex, the posterior margin generally slightly concave. The elytra are long, exceeding the abdomen, overlapping apically, with a distinct appendix and with the inner sector not forked, there being only two anteapical cells, with four apical cells. The hind wings have three closed apical cells. The external male genitalia are characterized by the elongation of the plates into attenuated finger-like processes. The oedagus usually has two processes apically.

### Cicadula punctifrons

Through the courtesy of Dr. Lawson specimens of **C. punctifrons** from Europe were loaned the writer. These proved to be quite distinct from the specimens of that species from the Western States. The markings on the vertex of the European species did not agree with specimens found in Kansas and Minnesota, the latter being larger and more robust, with no markings on the posterior margin of the vertex to correspond with those

*Contribution from the Department of Entomology, University of Kansas.

on the specimens from Europe. The plates of the European species were covered with many more hairs than were found in the Kansas specimens. The internal male genitalia of the European species are quite different from those of the American species, having the foot of the style extended into a sharp toe and the two finger-like processes of the oedagus arising at the apex of the shaft. In contrast, in the American specimens the foot of the style is not extended into a sharp toe and the finger-like processes of the oedagus arise before the end of the shaft. Then the genitalia of **C.punctifrons** from New York state were studied and these were found to agree exactly with the genitalia of the specimens from Europe. This showed conclusively that two species had been confused in the United States and that the western one was new to science while the eastern one has been correctly identified as **C. punctifrons.** In the writer's experience the color markings of the variety **repleta** vary so much that a distinct variety cannot be recognized. The black spots in the basal angle of the scutellum and the black marks on the anterior portion of the vertex might ordinarily distinguish the variety from the species, but the spots on the scutellum vary from large black spots to two dark patches showing through the pronotum and the patches on the anterior margin of vertex vary from black or brown to an entire absence of color. Apparently no distinguishing line can be drawn.

### Cicadula sexnotata

Specimens of **Cicadula sexnotata** from Russia were loaned the writer by E. W. Davis of Richfield, Utah. The specimens appeared to be more stoutly built than the American specimens. The spots on the posterior margin of the vertex were larger and more rounded than in the American specimens. A large number were dissected and the internal genitalia of the males were found to be different from those of the American specimens. The oedagi are of about the same size but in the European specimens a distinct bend occurs at the apex of the shaft where the two finger-like processes arise. The processes of the oedagus of the American specimens are compressed dorso-ventrad. The characteristic curve in the oedagus of the European specimens is a constant character that held true in the large number dissected. **C. sexnotata** was originally described in Europe, consequently the specimens in America which

have been found to be different must receive another name.

The American specimens have a great many color variations. The colorings are not clear cut, for all extremes can be found. In many specimens the middle pair of marks on the vertex are absent; in others they are very small. In some the pronotum is yellow, while in others it varies to dusky black. In some the basal angles of the scutellum are yellow; in others they are black or the black only shows through the posterior part of the pronotum. In some the elytra are yellow; in others they are spotted with dusky brown. In some the frons is very lightly marked; in others the markings are heavy and black. Nevertheless, the writer attempted to find some internal male genitalia differences that could be used to separate variously colored specimens. A large number of each color were dissected but no internal variations could be detected. The species seems to be one with many slight variations in color.

In 1877 Uhler described a form of **Cicadula sexnotata** and called it **C. divisa.** No types can be found at the present time. After examining the internal male genitalia of specimens conforming to the description of **C. divisa,** it seems clear that this was a name given to what we have been calling **C. sexnotata** and since the latter name can be applied now only to European specimens, **Cicadula divisa** becomes the name for what has hitherto in the United States been called **C. sexnotata.**

**Cicadula snowi** sp. n.

Figs. 1—1a.

A yellow species with two spots on vertex, allied to **C. punctifrons.** Length 4 to 5 mm.

**Form:**

Vertex bluntly angulate, one-fourth to one-fifth longer on middle than next the eye, about three times wider than long. Pronotum more than twice as wide as long, anterior margin broadly convex, lateral margins distinctly shorter than humeral margin, posterior margins broadly emarginate. Scutellum equal to width of vertex. Elytra exceeding abdomen; appendix distinct.

**Color:**

Yellow or yellowish green. Vertex with two large black spots near anterior border. Pronotum yellow.

Scutellum yellow. Elytra whitish hyaline, smoky at apex; nervures light. Face yellow.

**External genitalia:**

Male valve large, rectangular in shape, apex obtusely rounded; plates projecting beyond valve length of valve, then produced to two attenuated finger-like processes which exceed length of pygofer, bristles on plate extending over margin of pygofer.

**Internal male genitalia:**

Style with finger-like anterior processes; widest at point of attachment to connective, then slightly constricted either side of middle, suddenly narrowed to apical foot which bears a number of short stout spines on inner margin, the inner angle of apex being obtuse and the other acute. Oedagus equal to length of style, shaft moderately long, terminating in two short finger-like processes, compressed dorso-ventrally and ending in sharp points.

Described from one male specimen collected at Hamilton County, Kansas, elevation 3350 feet, by F. H. Snow. Type deposited in Snow Entomological Collection.

**Cicadula obsoleta** sp. n.
Figs. 2—2f

A yellow species with two black spots on vertex, allied to **C. pallida**... Length 3 mm.

**Form:**

Vertex, one-half wider than long; one-fourth longer on middle than next to eye; broadly rounding with front. Pronotum short, more than twice as wide as long, anterior margin broadly convex, lateral margins distinctly shorter than humeral margin, posterior margin about straight. Scutellum equal to vertex in width. Elytra exceeding abdomen by one-fifth their length; appendix distinct.

**Color:**

Yellow. Vertex yellow with two small brown spots near anterior margin; brown spots between ocelli and eye. Pronotum yellow. Scutellum yellow with transverse line black; frontal arcs brown; antennal sockets brown; brown spots on inner margin of eye.

**External genitalia:**

Female last ventral segment equal to preceding seg-

ment, slightly emarginate on posterior margin on middle; pygofer slightly shorter than black ovipositor, white spines on apical third. Male valve large, triangular; plates extending beyond valve apically in two finger-like processes, outer margin of plates with white spines.

**Internal male genitalia:**

Style with finger-like anterior process, widest at point of attachment to connective, then slightly constricted on either side of middle, suddenly narrowed to apical foot which bears a number of short stout spines on inner margin, the inner angle of apex being obtuse, the outer acute. Oedagus equal to style in length, shaft moderately elongate, terminating in two short finger-like processes with branch on inner margin of each process.

Holotype, male, Aransas County, Texas, June 6, 1928, by A. M. James.

Allotype, female, Aransas County, Texas, June 6, 1928, by A. M. James.

Paratypes, 7 females, Aransas County, Texas, June 6, 1928, by R. H. Beamer and A. M. James.

Orange County, Texas, September 14, 1928, by R. H. Beamer.

Douglas county, Kansas, 1927, by P. B. Lawson.

Allotype deposited in Dr. Osborn's collection;

All other types in Snow Entomological Collection.

**Cicadula major** sp. n.

Figs. 3—3f.

A large robust greenish-yellow species with two black spots on vertex, allied to **C. snowi.** Length of female 5.5 mm. to 7 mm.; length of males 4.5 mm. to 5.5 mm.

**Form:**

Vertex nearly parallel margined, very slightly longer on middle than next to eye, broadly rounding with front. Pronotum twice as wide as long, anterior margin broadly convex, posterior margin shallowly emarginate, lateral margins distinctly longer than humeral margin. Scutellum slightly greater than width of vertex. Elytra exceeding abdomen by more than one-third

their length; appendix distinct.

**Color:**

Dirty yellow. Vertex with two large black spots, sometimes two black or brown patches on or near anterior margin, sometimes small brown marks on apex. Pronotum dirty yellow. Scutellum yellow except for black transverse line, basal angles sometimes black. Elytra dirty yellow, sometimes with gray stripes; nervures light. Frons yellow, sometimes with light markings.

**External genitalia:**

Female last ventral segment about as long as preceding, posterior margin slightly produced. Pygofer large, widest at middle; equal to or slightly exceeding the ovipositor; apices of pygofer clothed with white spines. Male valve large, rounded posteriorly, about three-fourths as long as last ventral segment; plates broad basally, about twice as long as valve, margin bare narrowing to somewhat divergent apices; pygofer broad, exceeding the length of plates.

**Internal male genitalia:**

Styles narrowed slightly below attachment of connective, with distinct conical caudo-lateral protuberance which bears a number of fine hairs; foot rather elongate and scaly, with obtuse inner angle and acute outer angle. Oedagus shorter than style, shaft large with dorsal midway process, two curved sword-like processes near apex of shaft, apex of shaft blunt.

Holotype, male, Ramsey county, Minnesota, February, 1922.

Allotype, female, Douglas county, Kansas, June 18, 1929.

Paratypes, 3 males and 26 females—

Douglas, county, Kansas, June 6, 1929, by P. B. Lawson.

Hamilton county, Kansas, by F. H. Snow.

Ramsey county, Minnesota, July, 1922.

Ducheane, Utah, July 1926 by Vasco M. Tanner.

Allotype deposited in Dr. Osborn's collection; all other types in Snow Entomological Collection.

**Cicadula borealis sp. n.**

Figs. 4—4c.

A dirty-yellow species with black vertex and yellow median line, allied to **C. slossoni.** Length 3.5 mm. to 4.5 mm.

**Form:**

Vertex one-half wider than long, one-fourth longer on middle than next the eye, broadly rounding with front. Pronotum more than twice as wide as long, anterior margin broadly convex, lateral margin slightly shorter than humeral margin, posterior margin about straight. Scutellum about equal to vertex in width. Elytra exceeding abdomen by one-fifth their length; appendix distinct.

**Color:**

Dirty yellow. Vertex black with wide yellow median line continuing from margin of vertex across pronotum and scutellum; pale ocelli very conspicuous. Dark markings on anterior margin of pronotum extending toward posterior border on each side of yellow band. Scutellum with basal angles black, sometimes other markings. Elytra smoky with light spot on claval suture in male; nervures dark. Frons with black arcs somewhat convergent; sutural lines black; black spot under each eye.

**External genitalia:**

Female last ventral segment equal to preceding segment slightly emarginate on middle; pygofer slightly shorter than black ovipositor, very much narrowed on apical fifth, clothed with white spines. Male valve large, triangular; plates extending beyond valve ending in two finger-like processes; outer margin of plates with white spines; spiny pygofer extending beyond plates.

Described from a male (holotype) and female (allotype) collected at Everett, Washington, September 1, 1909 by J. A. Hyslop.

Holotype, deposited in Dr. Osborn's collection.
Allotype, deposited in Snow Entomological Collection.

**Cicadula osborni sp. n.**

Figs. 5—5a.

A black species with vertex black except for yellow

ocelli and yellow median line, allied to **C. potoria.** Length 4 mm.

**Form:**

Vertex more than twice as wide as long, one-sixth longer on middle than next the eye, broadly rounding with front. Pronotum short; twice as wide as long; anterior margin broadly convex, lateral margin distinctly shorter than humeral margin, posterior margin almost straight. Scutellum equal to vertex in width. Elytra exceeding abdomen by one-fifth their length; appendix distinct.

**Color:**

Black. Vertex practically solid black; sometimes with fine yellow median lines; ocelli yellow and conspicuous; posterior margin sometimes with slight yellow border. Pronotum solid black with small median yellow line on anterior third; sometimes two yellow spots on anterior margin widely divided. Scutellum black or with black basal angles and broad black transverse line. Elytra black, somewhat lighter toward tip, sometimes with light spot on claval suture; nervures dark; Frons with black convergent arcs; sutural lines black; black spot below eye; antennal sockets black.

**External genitalia:**

Male valve extra large, shape of isosceles triangle; plates large extending beyond valve about length of latter, terminating apically in two finger-like processes that extend beyond spiny pygofer; plates apparently bare of spines.

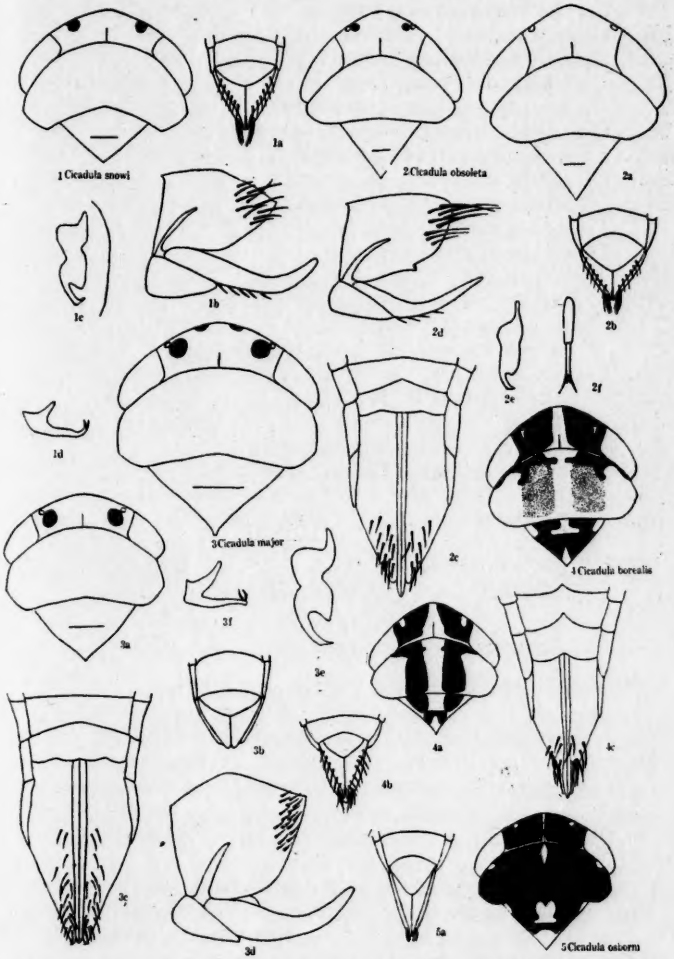
Holotype, male, Savonaski, Naknek Lake, Alaska, July 31, 1919.

Paratype, male, Savonaski, Naknek Lake, Alaska, July 31, 1919.

Holotype deposited in Dr. Osborn's collection.

Paratype deposited in Snow Entomological Collection.

The writer is justly indebted to Dr. Herbert Osborn for the generous loan of type specimens for study and especially for the specimens from which the last two species were discribed.


1 Cicadula snowi
1a
1b
1c
1d
2 Cicadula obsoleta
2a
2b
2c
2d
2e
2f
3 Cicadula major
3a
3b
3c
3d
3e
3f
4 Cicadula borealis
4a
4b
4c
5 Cicadula osborn
5a

**Explanation of Plate**

1. Cicadula snowi
1a. Cicadula snowi male genitalia
1b. Cicadula snowi pygofer
1c. Cicadula snowi clasper
1d. Cicadula snowi oedagus
2. Cicadula obsoleta, male
2a. Cicadula obsoleta, female
2b. Cicadula obsoleta, male genitalia
2c. Cicadula obsoleta, female gentilia
2d. Cicadula obsoleta, pygofer
2e. Cicadula obsoleta, clasper
2f. Cicadula obsoleta, oedagus
3. Cicadula major, female
3a. Cicadula major, male
3b. Cicadula major, male genitalia
3c. Cicadula major, female genitalia
3d. Cicadula major, pygofer
3e. Cicadula major, clasper
3f. Cicadula major, oedagus
4. Cicadula borealis, female
4a. Cicadula borealis, male
4b. Cicadula borealis, male genitalia
4c. Cicadula borealis, female genitalia
5. Cicadula osborni
5a. Cicadula osborni, male genitalia

## SOME BIOLOGICAL NOTES ON THE CERCOPIDAE NORTH OF MEXICO (HOMOPTERA).

*BY*

*KATHLEEN C. DOERING, Lawrence, Kans.**

### Philaenus as a Greenhouse Pest.

During the spring of 1928 Mr. Edward P. Breakey, Field Entomologist for the Wisconsin Department of Agriculture, was able to make some interesting observations on certain species of Cercopidae found on Baby Rambler roses, growing in the greenhouses of C. C. Pollworth, West Allis, Milwaukee County, Wisconsin.

He very kindly sent the specimens he was able to collect and the following notes to the writer. As Mr. Breakey and the writer have seen no records in the literature at our command concerning Cercopidae as greenhouse pests we thought that it might be advisable

*Contribution from the Department of Entomology, Lawrence, Kans.

to record the data.

Mr. Breakey's notes contained the following statements: "The roses had been secured from the Jackson and Perkins Company of Newark, New Jersey, and were brought into the greenhouses in December 1927 while dormant. Collecting was by the picking method for the use of the net was not only impracticable but impossible. Several mating pairs were taken. Three species are apparently in the lot collected. A large portion of the Cercopid population was still in the immature stages at this time. The presence of numerous large white masses of spittle on the small potted roses was an interesting sight. According to the workmen at the greenhouses it was not a new thing nor an unusual sight with them. They were asked to explain how they rid the plants of the insects and spittle before taking them to the Milwaukee store. They demonstrated by turning a strong stream of water on the plants. This seemed to be effective in washing away both spittle and insects unless the spittle had been invaded by a fungus in which case it was blackened and in such a state that it wouldn't wash off."

The species and varieties involved in Mr. Breakey's data according to determination by the author are **Philaenus leucophthalmus** var. **spumarius, Philaenus leucophthalmus** var. **marginellus** and **Philaenus leucophthalmus** var. **pallidus.**

Mr. Breakey stated that he was unable to follow up the investigation by further observations himself. However Mr. Adams of the Wisconsin office visited the greenhouse in 1929 and saw no sign of the infestation on the roses. This probably was due to the fact that the control measures were effective enough to get rid of the pests.

**Molting of Aphrophora permutata Uhler.**

In the February issue of the Entomological News Volume XXXIX, 1928, Doctor E. D. Ball gave an interesting description of the molting of **Monecphora bicincta** Say. Following this discussion of the molting habits of Cercopidae by Doctor Ball it appears to be well to add the notes taken by Doctor R. H. Beamer, University of Kansas, in regard to the molting of **Aphrophora permutata** Uhler.

During the summer of 1929 Doctor Beamer and his biological survey party were collecting in Sequoia National Park, Tulare, California. There they found

**Aphrophora permutata** Uhler to be very abundant both as nymphs and adults. The nymphs appeared to be living on perennials of various sorts such as legumes and others, which were growing in the Crescent and Log Meadows. Fortunately the party was able to observe the transformation of the fifth-instar nymphs to adults. This took place about eight o'clock in the morning. The nymph crawled out of the spittle mass and fastened itself to the stem. Then the skin burst along the dorsomedian line after which the insect entirely let go its previous hold with its legs, and flexed its body backward so that it remained connected to the old nymphal skin only by the tip of the abdomen. Later it stretched forward again, clinging to a new area of support with its legs while the tip of the abdomen was freed from the molted skin. By 10:30 o'clock many adults were fully colored and many were captured by using the net.

These observations check very accurately with Doctor Ball's statement of the molting of most Cercopidae. However the writer disagrees with Doctor Ball's statement to the effect that all the other genera but **Monecphora** crawl out of the spittle mass to make their transformation to adults. In the case of **Lepyronia quadrangularis** Say the author has found that the last molt takes place in the spittle mass in much the same manner as **Monecphora.** (See Kans. Univ. Sci. Bull. Vol: XIV, No. 21, p. 527.).

### The Occurrence of Clastoptera laenata Fowl. in North America.

During the summer of 1928 Doctor R. H. Beamer and his survey party collected six specimens of what apparently is **Clastoptera laenata** Fowler hitherto known from Mexico and South America. Two females and one male from Bowie Co. Texas, and one female and two males from Polk Co. Arkansas, were taken. The writer first determined the specific idenity by reading Fowler's description. For confirmation two specimens were sent to Mr. China of the British Museum for comparison with the types. Mr. China reported that they were undoubtedly **Clastoptera laenata** as nearly as he could ascertain without dissecting out the genitalia.

### Curious Walking Habits of Lepyronia gibbosa Ball.

While collecting **Lepyronia gibbosa** Ball in large numbers in Scott County, Kansas, during the summers of 1925 and 1926, Doctor R. H. Beamer noted a peculiar

habit of these rather large sized Cercopids. The insects were found on the prairie and not in particularly sandy places as is commonly thought to be their natural habitat. When collecting them Doctor Beamer observed that they were able to run backward as swiftly and efficiently as they did forward. This pecular habit was striking in that it was such a rapid movement, comparable to an automobile suddenly put in reverse.

**Clastoptera xanthocephala Germar As a Biter.**

While collecting **Clastoptera xanthocephala** Germar near Lake Charles, La., during the summer of 1928, Doctor R. H. Beamer and his survey party were much surprised to discover that this small insect was a vicious biter. Mrs. Beamer first made the discovery when she was repeatedly bitten by these insects in the process of taking specimens from her sweep net. When she placed her hand in the net insects alighting on her arm almost immediately proceeded to bite. This very interesting experience was soon reported by other members of the party. This species was breeding in countless numbers on a yellow Composite.

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## NOTE ON THE EMERGENCE OF TIBICEN PRUINOSA (SAY). (Homoptera—Cicadidae).

*BY*

*RAYMOND H. BEAMER, Lawrence, Kansas.**

A living female of **Tibicen pruinosa** (Say) was brought into the laboratory January 5, 1931. It had emerged the morning of January 4 from a flower pot containing a geranium. The specimen is small and the wings slightly crumpled, but is normal otherwise. The interesting data on this freakish emergence of a cicada was obtained by Doctor Philip A. Readio through an aquaintance.

The geranium was removed from a cemetery east of Lawrence, Kansas, and potted with the addition of a little garden soil in the fall of 1927. The cicada nymph, probably then in the 5th instar, doubtless was transplanted with the geranium. It is interesting to

*Contribution from the Department of Entomology, University of Kansas.

speculate whether warm temperature, enabling the nymph to feed throughout the year, hastened its emergence by several months, or whether an inadequate food supply had retarded its development, delaying its emergence from the summer before.

## KANSAS ACADEMY OF SCIENCE MEETING AT LAWRENCE, APRIL 24 and 25.

The 63rd annual meeting of the Kansas Academy of Science will be held April 24 and 25, 1931, at the University of Kansas, Lawrence. The forenoons of both days, Friday and Saturday, will be devoted to papers of general interest, registration and business, and Friday afternoon to the various section programs. The local committee is arranging for a banquet Friday evening which is to be followed by the president's address. Later in the evening Dr. George K. Burgess. Director of the U. S. Bureau of Standards, will give an address on the "Research at the Bureau of Standards".

A program containing full information regarding this and other matters regarding the meeting will be mailed out early in April to members and others applying for membership.

GEORGE E. JOHNSON, Secretary,
K. S. C. A. A. S:, Manhattan, Kansas

## KANSAS ENTOMOLOGICAL SOCIETY ANNUAL MEETING

**University of Kansas, Lawrence, Kansas, April 25, 1931.**

President Geo. A. Dean has called an annual meeting of the Kansas Entomological Society on April 25, 1931, in the Biology Building of the University of Kansas, Lawrence, Kansas. A business meeting will be held in the morning, beginning at 9:30. The afternoon will be taken up with the presentation of papers. All people interested in entomology are invited to attend this meeting.

R. L. PARKER, Secretary.
Manhattan, Kans., March 17, 1931.

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